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First Record for *Prosorhochmus americanus* (Nemertea, Hoplonemertea) in Virginia with Notes on its Natural History and Morphology

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ABSTRACT

The viviparous hoplonemertean *Prosorhochmus americanus* (Gibson et al.) is documented for the first time in Virginia. The nemertean occurs on the north jetty at Rudee Inlet, Virginia Beach, VA in the intertidal zone associated with stunted oysters and byssal threads of mussels. This finding raises the number of nemertean species recorded for Virginia to 23 and is the third report of this species in North America, extending its range approximately 650 km northward of the type locality. Field observations suggest that this gregarious worm is inactive during daytime low tides, and laboratory studies reveal that the worm feeds on amphipod crustaceans that co-occur on the jetty. New data for the stylet to basis ratio and observations on the number of juveniles per ovary are presented.

Key words: Nemertean, hoplonemertean, marine fauna, Rudee Inlet, Virginia.

INTRODUCTION

Nemerteans, or ribbon worms, comprise an understudied but abundant taxon of predominantly marine worms and represent an important component of both the infaunal and epifaunal benthic communities. Studies of their predatory habits also suggest that they play a role in structuring these marine communities (Thiel, 1998). The nemertean fauna of Virginia was surveyed in 1962 by W. E. McCaul, resulting in a publication that included two new species descriptions and an identification key (McCaul, 1963). A total of 22 species was found in the subtidal and intertidal waters of the York River, Chesapeake Bay, and the Eastern Shore of Virginia. Checklists of the marine benthic fauna of the York River (Gillete & Schaffner, 2009) and Chesapeake Bay (Wass, 1972) also include some of the species reported by McCaul as well as a few listed as unidentified. To our knowledge, no new nemertean records have been reported since McCaul's paper appeared. Here we report a new record for the viviparous nemertean *Prosorhochmus americanus* Gibson et al. (1986) from a marine epifaunal community of the Virginia Atlantic Coast, provide a brief description of the species as an identification aid, and present some observations on its natural history. This nemertean has been reported previously only from South Carolina (Gibson et al., 1986) and Florida (Maslakova & Norenburg, 2008).

MATERIALS AND METHODS

Specimens of *P. americanus* were found in the intertidal zone under the attached valves of stunted oysters (*Crassostrea virginica*) and among the byssal threads of blue mussels (*Mytilus edulis*) on the north jetty at Rudee Inlet, Virginia Beach, VA (36°49'48.80"N, 75°58'05.5"W) in September 2007, May 2009, August 2009, September 2009, and November 2009. The Rudee Inlet north jetty is approximately 256 meters in length and extends from the level of the boardwalk into the Atlantic Ocean. It consists of irregularly-shaped granite rocks 1-2 meters wide piled several layers high. Consistent zonation of fauna was not apparent on all rocks in the areas sampled, although a few exhibited an upper mixed oyster/barnacle zone and a lower zone of amphipod crustacean mud tubes.

Nemerteans were collected for identification and laboratory observation by prying oysters from the granite boulders using a table knife and gently pulling mussels from the rocks. Individuals of *P. americanus* clinging to oysters, rock surfaces or crawling from byssal threads of mussels were transferred to plastic bags containing seawater and transported to the laboratory for observation. Alternatively, mussels and oysters were pried from the rocks, transported to the laboratory in bags of seawater, transferred to culture dishes, and allowed to stand for several days. These dishes were monitored daily, and all worms that crawled to the edge of the dish from the mussel clumps or oysters were transferred with a pipette to dishes containing fresh seawater for further observation. All collections were made during daylight hours at low tide.

Identification was accomplished using the species description of Gibson et al. (1986) and the updated information in Maslakova & Norenburg (2008). Voucher specimens are deposited in the United States National Museum of Natural History. Stylets and stylet bases were measured from digital images using Image J software (Abramoff et al., 2004).

RESULTS AND DISCUSSION

Prosorhochmus americanus was found in the intertidal zone under oysters and among the byssal threads of the blue mussel, where the worms are likely protected from desiccation during low tide. This species tends to be gregarious with several individuals typically situated under a single oyster. The worms did not appear to be active during daylight hours at low tides, and additional field observations will be necessary to determine when they search for prey.

Besides mussels and oysters, animals occurring on the rocks with *P. americanus* included amphipods (*Jassa falcata*, *Corophium* cf. *insidiosum*, and *Hyale plumulosa*), isopods (*Sphaeroma quadridentatum*), and nemerteans (*Tubulanus pellucidus*, *Zygonemertes virescens*, and *Lineus bicolor*). The other nemerteans were never observed in *P. americanus* aggregates, however, and were not abundant. The amphipod *Hyale plumulosa* was often found in large numbers in the immediate vicinity of *P. americanus.* Preliminary laboratory experiments reveal that *P. americanus* feeds on amphipod crustaceans (Caplins and Turbeville, pers. obs.).

Prosorhochmus americanus is a yellow-orange worm (Fig. 1), and no other intertidal nemertean reported for Virginia exhibits a similar coloration. Adults range in size from 4-16 mm in length and 0.2-1 mm in width. There are four conspicuous black ocelli at

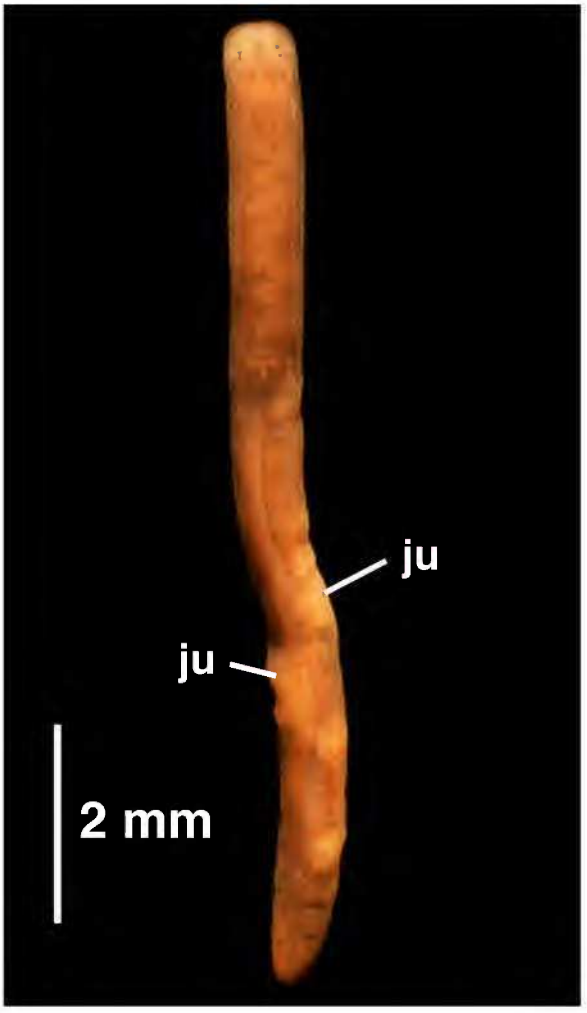

Fig. 1. Adult *Prosorhochmus americanus* containing juveniles (ju). The yellow-orange color distinguishes the nemertean from other intertidal epifaunal species recorded from Virginia. The specimen was photographed after relaxation in $MgCl_2$.

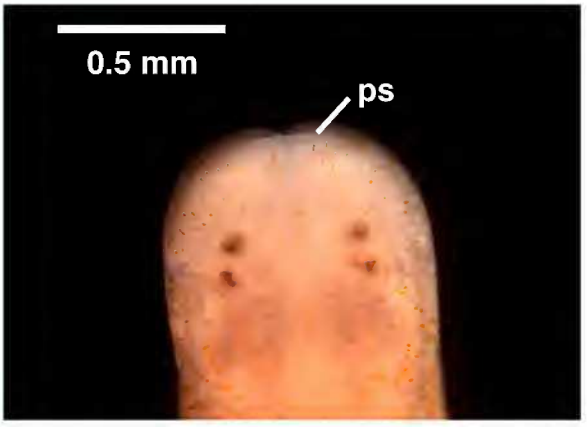

Fig. 2. Dorsal side of the anterior end of *Prosorhochmus americanus,* showing the prosorhochmid smile (ps), which is characteristic of the genus.

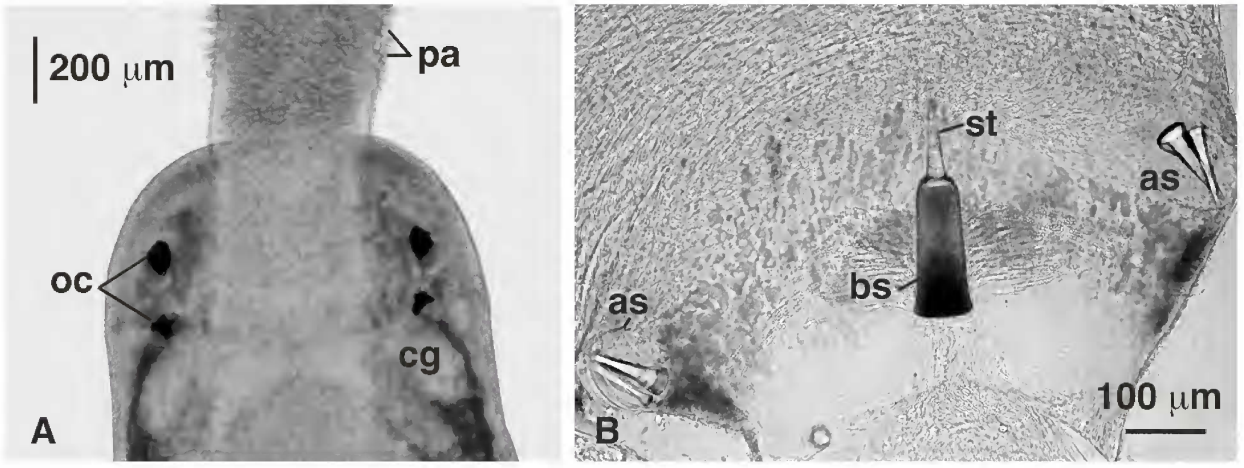

Fig. 3. Light micrographs of the anterior end and stylet apparatus of a mature individual of *Prosorhochmus americanus*. A. The compressed anterior end, revealing the partially everted proboscis with papillae (pa), four ocelli (oc), and dorsal cerebral ganglia (cg). B. The stylet apparatus. The central stylet (st) rests on an organic basis (bs). Reserve stylets are situated in accessory stylet sacs (as).

the anterior end that appear partially fused in some individuals. The anterior end bears a conspicuous dorsal crescent-shaped body wall fold (Fig. 2) that has been dubbed the 'prosorhochmid smile' (see Maslakova & Norenburg, 2008). This character is diagnostic for the genus. The cream-colored proboscis is nearly as long as the body of the worm, and the outer epithelium is papillate along much of its length (Fig. 3A). The proboscis is armed with a spike-shaped stylet resting on a truncated basis (Fig. 3B) and is situated in the middle region of the eversible proboscis. There are two accessory stylet sacs, each containing 2-4 reserve (= accessory) stylets that lie anterolaterally to the stylet apparatus (Fig. 3B). The stylet to basis (S/B) ratio ranges from 0.58-0.74 with an average of 0.65 (Table 1). It is important to note that the ratio (0.45-0.5) reported by Gibson et al. (1986) is based on only 3 individuals, one of which was immature, and the small sample size likely accounts for the difference in ratios reported here. Intraspecific variation in the S/B ratio is not uncommon, for example ranging from (0.38-0.65) in *Prosorhochmus chafarinensis* (Maslakova & Norenburg, 2008) and may be correlated with body size.

Prosorhochmus americanus is hermaphroditic and viviparous. Most individuals collected in May through November 2009 contained developing embryos as well as juveniles (Fig. 1). In the laboratory we have observed juveniles exiting the adult through its anus (anal parturition), confirming the observation of Gibson et al. (1986). Actively gliding juveniles measured within 24 h of emergence ranged in length from 2.5-4.5 mm with an average length of 3.7 mm (n = 36 individuals).

One character that distinguishes *P. americanus* from the closely related European species *P. claparedii* is the presence of more than one juvenile per ovary in the former species (Fig. 4; see Gibson et al., 1986 and Maslakova & Norenburg, 2008). Our observations suggest that this character is variable in the Rudee Inlet population: the ovaries of some individuals contained only a single juvenile whereas the ovaries of other specimens contained one or two juveniles (Fig. 4). This may reflect intraspecific variation, and more observations for *P. claparedii* are needed to determine if the feature is variable for this species or if a single juvenile per ovary is diagnostic (see Maslakova & Norenburg, 2008 for discussion).

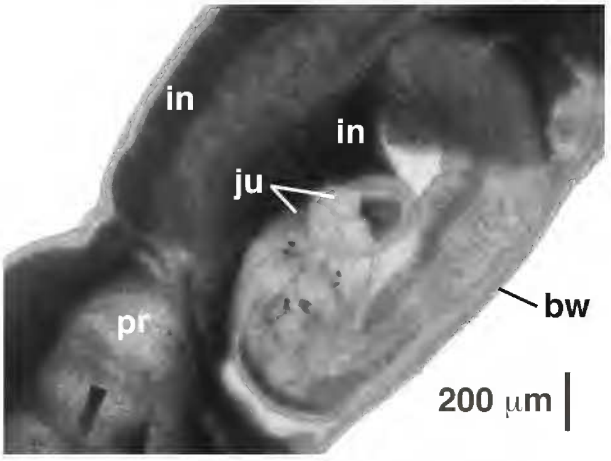

Fig. 4. Light micrograph of the body wall (bw) of an adult individual of *Prosorhochmus americanus*, showing two juveniles (ju) at different developmental stages within a single ovary. in - intestine, pr - proboscis.

Table 1. Stylet apparatus measurements.

Specimen	Stylet (S, μm)	Basis (B, μm)	S/B
1	98.6	143.8	0.68
2	90.4	133.1	0.68
3	75.4	117.9	0.64
4	80.7	120.5	0.67
5	83.1	112.2	0.74
6	78.3	120.7	0.65
7	57.8	99.3	0.58
8	73.2	123.4	0.60
9	92.6	148.0	0.65
10	113.0	188.0	0.60
Average	84.31	130.69	0.649

Provisional analyses of two mitochondrial genetic markers revealed complete identity between these species, but only two individuals of *P. claparedii* and one of *P. americanus* were available for comparison (Maslakova & Norenburg, 2008). Additional genetic comparisons including nuclear markers with a larger sample will be necessary to definitively establish if these represent separate species as suggested by one internal anatomical difference (purple cephalic glands) and the difference in the number of developing juveniles per ovary (see Maslakova & Norenburg, 2008 for detailed discussion).

Prosorhochmus americanus is the only species of the genus reported from North America. It has been previously recorded only in Florida (Maslakova & Norenburg, 2008) and South Carolina (Gibson et al., 1986). The type locality is the North Jetty at the mouth of Winyah Bay near Georgetown, SC. Additional populations were found on rock jetties at Murrells Inlet, SC, on the north jetty at the mouth of Charleston Harbor, near Charleston, SC, and on rock groins located on the high-energy beach at Pawleys Island, SC (Gibson et al., 1986; Turbeville, pers. obs.). Another population was found associated with the fouling community on rocks at Oregon Inlet, North Carolina in 2007 (C. R. Runnels and J. M. Turbeville, pers. obs.), and several populations were discovered on the southeast coast of Florida by J. L. Norenburg, Smithsonian Institution (Maslakova & Norenburg, 2008). Florida specimens were situated under and among coral rubble at Sebastian Inlet, among rubble and on the North Jetty near Fort Pierce, from concrete pilings in the Indian River near Lake Worth Inlet, and from cement pilings at Virginia Key. Our finding extends the range of this species northward of the type locality by approximately 650 km (400 miles). Whether this represents a poleward shift attributable to global warming, as suggested for some other intertidal and subtidal invertebrates (see Parmesan, 2006; Jones et al., 2009), is unclear. It is possible that this species was overlooked in previous faunal surveys. Further field work will be required to assess the extent of the range of *P. americanus* in Virginia and North America.

The dispersal mechanism of this species has not been established, but we speculate that, because it lacks a pelagic larval stage and is part of the fouling community, dispersal likely occurs by rafting on algae and debris or transport on boat hulls, as has been documented for various benthic invertebrates, including some nemerteans (see Highsmith, 1985; Thiel & Gutow, 2005a, b).

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Pistia stratiotes L. (Water Lettuce) Discovered in Southeastern Virginia

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ABSTRACT

Pistia stratiotes L. (water lettuce) is newly reported for Virginia. The species was prevalent in Reedtown Lake in Virginia Beach during November 2007. The invasion of *P. stratiotes* can be detrimental to a waterbody because it can rapidly reproduce and form dense mats, increase siltation, reduce or deplete oxygen levels, and reduce the suitability of benthic substrates for nesting by fish or as a habitat for macroinvertebrates.

Key words: aquatic invasive species, hydrophyte, *Pistia stratiotes*, Virginia, Virginia Beach, water lettuce.

INTRODUCTION

Pistia stratiotes L. (water lettuce) is a free-floating monocotyledonous (Anonymous, n.d.) perennial (but may act as an annual) herb in the Aroid family (Dray & Center, 2002) that was first reported in Florida, USA in 1765. It now occurs on all continents except Europe and Antarctica, making it one of the most widely distributed hydrophytes (Hilhorst, n.d.). Water lettuce has been found in lakes, ponds, reservoirs, canals, and slow-flowing streams and rivers (Dray & Center, 2002). The most common means of spreading the species from